

NOTES ON THE DISTRIBUTION, HOST RANGE, PLANT SIZE, PHENOLOGY,
AND SEX RATIO OF TWO RARE DWARF MISTLETOES FROM CENTRAL
AMERICA: *ARCEUTHOBIUM HAWKSWORTHII* AND *A. HONDURENSE*

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ABSTRACT

New information on the distribution, host range, plant size, flowering periods, and sex ratio of *Arceuthobium hawksworthii* and *A. hondurense* are provided based on plant collections, field-observations and roadside-surveys conducted in 1998 in Belize, Guatemala, and Honduras, Central America. *Arceuthobium hawksworthii* parasitizes *Pinus caribaea* var. *hondurensis* and *P. oocarpa* var. *ochoterenai* in Belize, but the latter pine is less susceptible and classified here as a secondary host. Our surveys in the *P. caribaea* var. *hondurensis* forests near Poptun, Guatemala indicate that *A. hawksworthii* does not occur there, and therefore, this mistletoe probably does not occur in Guatemala. Our surveys of the Mountain Pine Ridge Region of western Belize indicate that *A. hawksworthii* occurs there at elevations between 520-900 m and is distributed in an area of approximately 250 sq. km. Therefore, this dwarf mistletoe probably has the most restricted geographic range of any known dwarf mistletoe. No new populations of *A. hondurense* were discovered in Honduras, but our examination of previously reported populations of this dwarf mistletoe indicates that it only parasitizes *P. oocarpa* vars. *oocarpa* and *ochoterenai* and not *P. maximinoi* as previously reported. Additional plant measurements of *A. hawksworthii* and *A. hondurense* are reported, including new maximum records of plant height for both species. The sex ratio of both dwarf mistletoes is 1:1, but the sample size for *A.*

hondurensis was small (64 plants) and additional sampling will be needed to confirm this finding.

KEY WORDS: Hawksworth's dwarf mistletoe, Honduran dwarf mistletoe, Caribbean pine

BACKGROUND

Dwarf mistletoes (*Arceuthobium* spp., Viscaceae) are parasitic flowering plants that parasitize members of the Pinaceae in the New World and Pinaceae and Cupressaceae in the Old World. Although the dwarf mistletoes are widespread and common parasites of the Pinaceae in the United States and México, there are only a few taxa known from Central America. Little is known regarding the distribution, host range, ecology, and phenology of the Central American taxa (Hawksworth & Wiens 1996).

Two of the rarest dwarf mistletoes known occur in Belize and Honduras: *Arceuthobium hawksworthii* Wiens & C.G. Shaw, III and *A. hondurensis* Hawksw. & Wiens. *Arceuthobium hawksworthii* is known only from the Mountain Pine Ridge Region (MPR) of western Belize (Wiens & Shaw 1994) and *A. hondurensis* is only known from two areas of Honduras (Hawksworth & Wiens 1972, 1996). Hawksworth & Wiens (1996) speculated that *A. hondurensis* may be so rare in Honduras that it might be in danger of extinction if the extensive harvesting of pine forests in Honduras continues.

Specimens of *Arceuthobium hawksworthii* have been collected by various investigators from the MPR since 1959, but this taxon was not described until recently (Wiens & Shaw 1994). It was previously considered to represent a disjunct population of *Arceuthobium globosum* Hawksw. & Wiens (Hawksworth & Wiens 1972) and later was classified as *A. aureum* Hawksw. & Wiens subsp. *aureum* (Hawksworth & Wiens 1977). However, a detailed analysis of the Belizean populations by Wiens & Shaw (1994) indicated these populations are distinct from the *A. aureum* subsp. *aureum* populations found in the western and central highlands of Guatemala. Wiens & Shaw (1994) speculated that *A. hawksworthii* might occur in eastern Guatemala in a disjunct population of its principal host, *Pinus caribaea* Morelet var. *hondurensis* (Senec. Barr. & Golf., that occurs in the vicinity of Poptun (Perry 1991). They also indicated that they did not observe *A. hawksworthii* below an elevation of 700 m in the MPR although previous reports place it as low as 520 m in this Region. Specimens of *A. hawksworthii* collected by A. Carty at high elevations (above 900 m) near Cooma Cairn in 1981 were tentatively identified as hybrids of *Pinus caribaea* var. *hondurensis* and *Pinus oocarpa* Schiede var. *ochoterenai* Mart. Wiens & Shaw (1994) reported they were unable to confirm if *A. hawksworthii* was parasitizing *Pinus oocarpa* var. *ochoterenai* or hybrids of these species at this location.

Arceuthobium hondurensis was described in 1970 from populations southeast of Tegucigalpa, Honduras, but only one additional population of this rare dwarf mistletoe has been discovered since then (Hawksworth & Wiens 1970, 1972, 1984, 1996). It is presently known from only two general localities in Honduras; in the Piedra Herrada

Mountains, approximately 22 km southeast of Tegucigalpa and from approximately 20 km northwest of San Pedro Sula in Cusuco National Park (Hawksworth & Wiens 1996). Thus far, this dwarf mistletoe has only been reported parasitizing *Pinus oocarpa* var. *oocarpa* and *P. maximinoi* H.E. Moore (Hawksworth & Wiens 1996). So little is known about its host range and distribution in Central America that it is considered to be the rarest dwarf mistletoe described from the New World. It may also occur in El Salvador in the vicinity of Montecristo (Santa Ana Province) near the borders of Honduras and Guatemala, but this tentative report (Hawksworth & Wiens 1996) needs to be confirmed.

SAMPLING AND FIELD OBSERVATIONS

Distribution

From March 3--4, May 29--June 1, and August 18--20, 1998 we conducted roadside-surveys in the pine forests of the MPR of western Belize. *Arceuthobium hawksworthii* is common in the MPR east of Augustine, particularly along the Baldy Beacon, Hidden Valley Falls, Brunton Trail, Orchid Hill, and Granite Cairn Roads. We observed populations of *A. hawksworthii* at an elevation of 520 m at several locations, but the mistletoe is most common above 600 m. The reasons for the lower elevational limitation are unclear, because its pine hosts are continuously distributed throughout the MPR at elevations below 500 m. In addition, as was reported by Wiens & Shaw (1994) we did not observe *A. hawksworthii* in the lower elevation *Pinus caribaea* var. *hondurensis* forests closer to the coast of Belize. Our surveys now provide adequate information to estimate the distribution of this rare dwarf mistletoe in the MPR. Because we did not find populations of *A. hawksworthii* below 520 m in the MPR, we used this lower elevational limit and our roadside-survey observations to estimate the approximate distribution of *A. hawksworthii* (Figure 1); it only occurs in an area of approximately 250 sq. km. Because the highlands of the MPR are geologically distinct and have evidently been isolated from other highland regions of Central America for several thousand years (Bateson 1972; Bateson & Hall 1977; Means 1997), *A. hawksworthii* has been separated from other dwarf mistletoe populations long enough to have evolved into a distinct taxon, endemic to the MPR.

On March 6, 1998 we surveyed the pine populations near Poptun, Guatemala. These pine populations are typical *Pinus caribaea* var. *hondurensis* as reported by Perry (1991). We estimate the overall forest area dominated by pine near Poptun to be restricted to about 300 sq. km; located adjacent to the Belizean border, extending 38 km west; and south of the Machaquila River, extending 8-12 km south of the river (Perry 1991 and personal communication with Placido Castellanos of Machiquila, Guatemala). Because of this limited area, we were able to survey the majority of the pine forest (elevation 500-700 m) in the Poptun area. We did not observe *Arceuthobium hawksworthii* in these forests and we believe it does not occur there. Therefore, we are doubtful that *A. hawksworthii* occurs in Guatemala.

In Honduras we relocated the population of *Arceuthobium hondurense* northwest of Cofradia (approximately 20 km west of San Pedro Sula) in Cusuco National Park (Figure 2) at an elevation of 1400 m (ca. 3 km northwest of the village of Buenos

Aires). This is the same population of *A. hondurensis* sampled by J.S. Beatty in 1991 that is reported in Hawksworth & Wiens (1996). Our limited roadside surveys in this area did not reveal any other populations of this rare dwarf mistletoe in northwestern Honduras, but we suspect it occurs elsewhere within and in the vicinity of Cusuco National Park.

Host Range

We examined host material (needles and mature female cones) collected from several pines at different elevations in the MPR in an attempt to clarify the identity of the hosts parasitized by *Arceuthobium hawksworthii*. Specimens of foliage and female cones of dwarf mistletoe-infected pines were collected and forwarded to J.P. Perry, Jr. for confirmation of our tentative field identifications, including a sample taken from a putative hybrid (*Pinus caribaea* var. *hondurensis* × *Pinus oocarpa* var. *ochoterenai*). In all cases our identification of the host agreed with those of Mr. Perry, except that he felt the putative hybrid was best classified as *Pinus oocarpa* var. *ochoterenai*. Our field observations from the MPR confirm that *Pinus caribaea* var. *hondurensis* is the principal host of *A. hawksworthii* in this area. This pine is severely infected in many areas and tree mortality is common in severely infested pine stands.

We were unable to find locations with sufficient numbers of *Pinus oocarpa* var. *ochoterenai* growing near severely infected *P. caribaea* var. *hondurensis* to gather quantitative data on the comparative susceptibility of these hosts to *Arceuthobium hawksworthii*. However, based on our observations at several locations where both *P. caribaea* var. *hondurensis* and *P. oocarpa* var. *ochoterenai* were both parasitized by *A. hawksworthii*, we believe the latter pine is less susceptible to this dwarf mistletoe. In some areas where many *P. caribaea* var. *hondurensis* were severely infected and where many dead *P. caribaea* var. *hondurensis* had evidence of past mistletoe infection (witches--brooms), infection of occasional, large (> 10 m in height) *P. oocarpa* var. *ochoterenai* was much less severe. In addition, we observed infection of small *P. caribaea* var. *hondurensis* (less than 2 m in height) under larger, infected *P. caribaea* var. *hondurensis*, but small *P. oocarpa* var. *ochoterenai* growing in the same areas were not infected. We tentatively classify *P. oocarpa* var. *ochoterenai* as a secondary host of *A. hawksworthii* using the host susceptibility classification system of Hawksworth & Wiens (1972).

Wiens & Shaw (1994) reported that a species of *Psittacanthus* is common on *Pinus caribaea* var. *hondurensis* in the lowlands of Belize and in the MPR. We frequently observed this mistletoe on pines in these areas as well and identified the mistletoe as *Psittacanthus pinicola* Kuijt. This species of *Psittacanthus* is distinguished by its red to orange flowers with yellow-green tips which are about 4 cm long with a conspicuous ligule at their base (Kuijt 1987). Another distinctive feature is that it has leaves whose margins taper into the petiole. We also observed both *Psittacanthus pinicola* and *Arceuthobium hawksworthii* parasitizing the same tree, and in some cases the same branch, in the MPR as was reported by Wiens & Shaw (1994).

The taxonomic status of the *Pinus oocarpa* populations in the MPR is still in question and some investigators consider these populations to be more representative of *P. tecumananii* (Schw.) Eguluz & Perry (Farjon & Styles 1997). Other

investigators consider these populations to represent *P. oocarpa* var. *ochoterenai* (Hunt 1962; Perry 1991). We have chosen to follow the classification of Perry (1991).

Hawksworth & Wiens (1996) reported the host of *Arceuthobium hondurense* in northwestern Honduras is *Pinus maximinoi*, but this host classification was tentative and based on information provided to one of us (J.S. Beatty) by Honduran Forestry personnel. Our examination of the pines being parasitized in northwestern Honduras indicates that the host is *P. oocarpa* var. *ochoterenai* and not *P. maximinoi* as reported by Hawksworth & Wiens. Therefore, we conclude that *A. hondurense* has only been found parasitizing *P. oocarpa* vars. *oocarpa* and *ochoterenai* in Honduras, thus far. Because so little is currently known about the distribution and host range of *A. hondurense*, it is likely that once its distribution is better documented in Central America, it will be found parasitizing other species of *Pinus*.

Plant Measurements

Additional measurements of male and female plants were made on fresh specimens of *Arceuthobium hawksworthii* in order to add to the small amount of data available for this species. Plant height (nearest 0.1 cm), the width of the base of shoots (nearest 0.1 mm), and the length (nearest 1.0 mm), and width of the third internode (nearest 0.1 mm) were measured on the dominant shoots from 150 infections of each sex. Means, standard deviations, maximums, and minimums for these four morphological characters are presented below:

	Female				Male			
	Mean	S. Dev.	Max.	Min.	Mean	S. Dev.	Max.	Min.
Height (cm)	15.6	3.4	27.8	9.6	15.7	3.8	32.8	7.8
Base (mm)	3.8	0.8	6.9	2.1	3.5	0.9	7.8	2.3
Third Internode:								
Length (mm)	12.2	2.3	19.0	7.0	11.8	2.6	21.0	6.0
Width (mm)	2.7	0.5	4.5	1.9	2.5	0.5	4.4	1.7

The largest plants we found were males (approximately 33 cm) and slightly exceeded the maximum plant height (30 cm) reported by Wiens & Shaw (1994); otherwise, these sizes and ranges are consistent with those reported by Wiens & Shaw. It is interesting to note that based on our measurements of 300 plants, which is the largest set of plant measurements completed for a dwarf mistletoe of which we are aware (see Hawksworth & Wiens 1996), the set of morphological characters we

measured for female and male plants of *Arceuthobium hawksworthii* are the nearly the same.

Additional measurements of male and female plants were made on fresh specimens of *Arceuthobium hondurensense* collected on March 10 and August 21, 1998. Measurements were the same as for *A. hawksworthii* (above), but only 25 infections of each sex were measured for *A. hondurensense*. Means, standard deviations, maximums, and minimums for these four morphological characters are presented below:

	Female				Male			
	Mean	S. Dev.	Max.	Min.	Mean	S. Dev.	Max.	Min.
Height (cm)	13.6	3.0	19.4	9.1	20.2	4.5	32.2	11.5
Base (mm)	4.0	0.6	5.8	2.8	4.4	0.7	6.3	3.6
Third Internode:								
Length (mm)	10.7	2.5	16.0	7.0	14.0	2.3	18.0	8.0
Width (mm)	3.3	0.3	3.9	2.7	3.4	0.5	4.8	2.8

The sizes and ranges of these characters for female plants are nearly identical to those reported for this taxon (both sexes combined) by Hawksworth & Wiens (1972, 1996), but the sizes and ranges for male plants are larger. For instance, the largest plant(s) reported by Hawksworth & Wiens (either sex) was only 21 cm compared to the 32 cm male plant we measured from southeast of Tegucigalpa.

Phenology

Male plants of *Arceuthobium hawksworthii* were still flowering as of March 5 at elevations over 800 m in the MPR. As was reported by Wiens & Shaw (1994) male flowers had perianths that were predominantly 3-merous and rarely 4-merous, but we did not observe male flowers with the vivid red color inside the perianth lobes described by Wiens & Shaw. The male flowers we observed were the same color on the inside as on the outside--a slightly darker shade of yellowish-brown than the staminate spike shoot color. Female flowers were in an early stage of fruit development on many female plants and no mature fruits were observed on female plants in early March. Wiens & Shaw (1994) speculated that *A. hawksworthii* dispersed seed in June. However, our observations of fruit in early June indicated that they were not near maturity. Our observations of fruit on August 18--20, 1998 found that only a few fruits were nearing maturity, but no fruit were dispersing seed then and attempts to manually press seeds out of fruit were unsuccessful. Anthesis was not

occurring in either June or August. Although Wiens & Shaw (1994) speculated that *A. hawksworthii* has multiple periods of anthesis and seed dispersal, this taxon appears to only have one period of anthesis annually (mid January through early March) and one annual seed dispersal period that we estimate is from mid September through October based on our observations in August, 1998. Therefore, fruit maturation requires 6-7 months.

Male plants of *Arceuthobium hondurense* had begun anthesis and some fruits on female plants were beginning to disperse seed on August 21. Therefore, flowering and seed dispersal of *A. hondurense* starts slightly earlier than September which was reported by Hawksworth & Wiens (1972, 1996) as the period of anthesis and seed dispersal. The inside of male flower perianths of *A. hondurense* are bright red as previously reported (Hawksworth & Wiens 1972, 1996), but perianth lobes become the same color as male shoots when dried. Male and female plants of *A. hondurense* demonstrate a high degree of sexual dimorphism. Male plants are more open and spreading, and female plants are compact and more densely branched.

Sex Ratio

Dwarf mistletoes are dioecious and most species have a 1:1 sex ratio (Hawksworth & Wiens 1996), but some species are reported to have a female-biased sex ratio (Hawksworth & Wiens 1996; Wiens *et al.* 1996). On May 31 and August 19 we systematically examined separate infections of *Arceuthobium hawksworthii* and determined their sex based on flower morphology of mature plants. Twenty infected *Pinus caribaea* var. *hondurensis* were felled and infections on each branch, starting at the bottom of the tree, were examined for infections with mature plants. We sexed 1066 infections; 522 were male and 544 were female. Therefore, the sex ratio of *A. hawksworthii* is 1:1, like most species of the genus.

On August 21 we systematically examined infections on five *Pinus oocarpa* and determined the sex of 64 mature plants of *A. hondurense*. Mature plants that could be sexed from the ground on small trees (less than 6 m in height) using binoculars were included in this sample and only one larger tree (10 m in height) with several infections with mature plants was destructively sampled. The sex ratio of this small sample of mature plants was 1:1 (31 females and 33 males), but a larger sample is needed to confirm this preliminary finding.

Plant Collections

Specimens of male and female plants of *Arceuthobium hawksworthii* from the MPR were deposited at the Deaver Herbarium, Northern Arizona University, Flagstaff, AZ, the US National Herbarium, Washington, D.C. and the Forestry Herbarium, Ministry of Agriculture, Belmopan, Belize. Specimens of male and female plants of *A. hondurense* were collected from Cusuco National Park and from southeast of Tegucigalpa and deposited at the Deaver Herbarium, Northern Arizona University, Flagstaff, AZ, the US National Herbarium, Washington, D.C., the Herbario Paul C. Standley, Escuela Agrícola Panamericana, Tegucigalpa, Honduras, and at Southern Illinois University, Carbondale, IL.

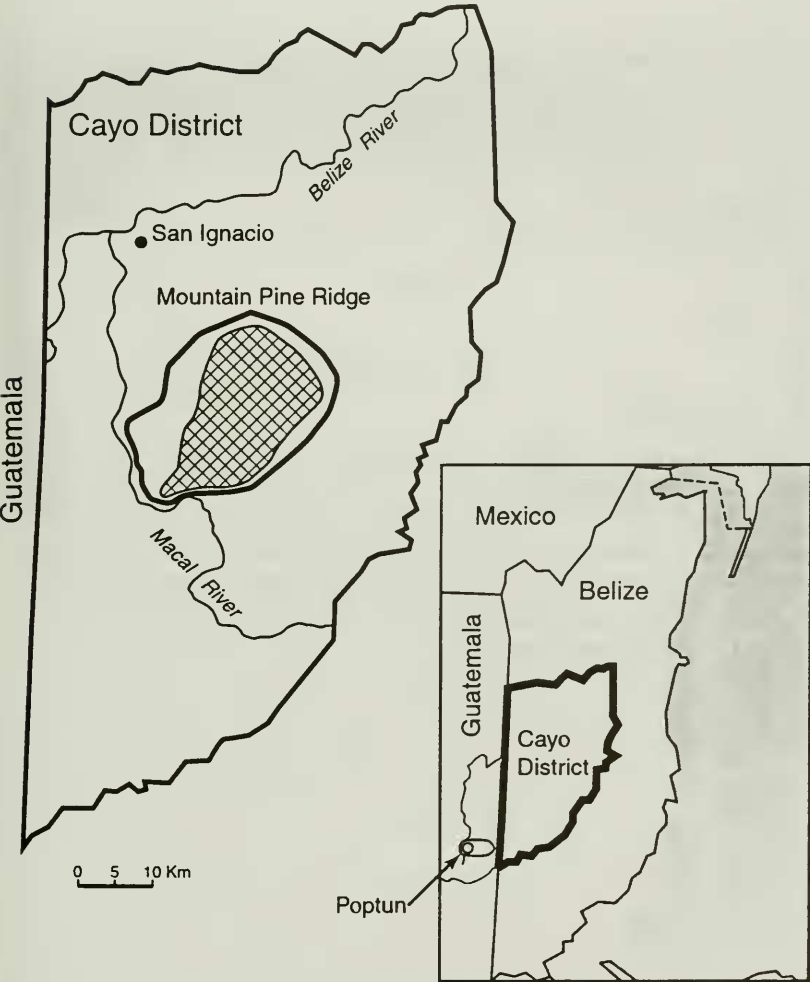


Figure 1. Location of the Mountain Pine Ridge Region (MPR) in Belize and the approximate distribution of *Arceuthobium hawksworthii* within the MPR. Thick line in blow-up represents the MPR and the cross-hatched area represents the distribution of *A. hawksworthii* (approximately 250 sq. km). Approximate area of pine forests surveyed in Guatemala is indicated by dark line around Poptun.



Figure 2. Location of the only known populations of *Arceuthobium hondurense* in Honduras: Cusuco National Park (circle) and in the Piedra Herrada Mountains southeast of Tegucigalpa (star).

Because the nuclear ribosomal DNA cistron has not been sequenced for *Arceuthobium hondurense* as has been done for several other species of *Arceuthobium* (Nickrent *et al.* 1994; Nickrent 1996), specimens of plant material of *A. hondurense* from both of its known locations in Honduras were sent to Dr. D.L. Nickrent, Southern Illinois University, Carbondale, IL. Dr. Nickrent will complete a molecular analysis of the internal transcribed spacer regions for *A. hondurense* and determine if this information provides insights into the phylogenetic relationships of this dwarf mistletoe with other North American species, particularly *A. bicarinatum* Urban which occurs on the island of Hispaniola and is morphologically similar to *A. hondurense*.

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